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Resolving the Radon Problem in Clinton, New Jersey, Houses

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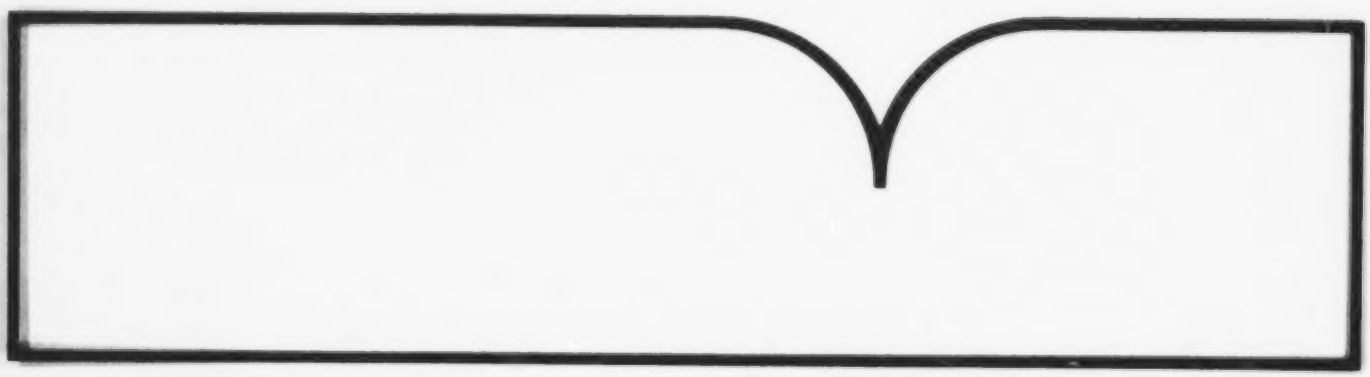

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RESOLVING THE RADON PROBLEM IN CLINTON, NEW JERSEY, HOUSES

by

Michael C. Osborne
Air and Energy Engineering Research Laboratory
U.S. Environmental Protection Agency
Research Triangle Park NC 27711

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AIR AND ENERGY ENGINEERING RESEARCH LABORATORY
OFFICE OF RESEARCH AND DEVELOPMENT
U.S. ENVIRONMENTAL PROTECTION AGENCY
RESEARCH TRIANGLE PARK, NC 27711

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16. ABSTRACT The paper discusses the resolution of a radon problem in Clinton, New Jersey, where significantly elevated radon concentrations were found in several adjacent houses. The U.S. EPA screened 56 of the houses and selected 10 for demonstration of radon reduction techniques. Each of the 10 houses received an intensive radon diagnostic evaluation before a house-specific radon reduction plan was developed. Before and after the plans were implemented, radon concentrations were determined by charcoal canisters and continuous radon monitors. A variety of sealing and subslab depressurization techniques were applied to the 10 houses. Radon concentrations were reduced by over 95% in all 10 houses. Five meetings were held to explain to homeowners the radion reduction techniques being implemented and to answer questions of homeowners interested in applying similar radon reduction efforts to their houses.

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Radon	Stationary Sources	07B
Residential Buildings	Depressurization	13M
Monitors		14G
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Michael C. Osborne
U.S. EPA, Air and Energy Engineering Research Laboratory
Research Triangle Park, North Carolina, USA

ABSTRACT

Significantly elevated radon concentrations were found in several adjacent houses in Clinton, New Jersey. The United States Environmental Protection Agency screened 56 of the houses and selected 10 for demonstration of radon reduction techniques. Each of the 10 houses received an intensive radon diagnostic evaluation before a house-specific radon reduction plan was developed. Before and after the plans were implemented, radon concentrations were determined by charcoal canisters and continuous radon monitors. A variety of sealing and sub-slab depressurization techniques were applied to the 10 houses. Radon concentrations were reduced by over 95% in all 10 houses. Five homeowners meetings were held to explain the radon reduction techniques being implemented and to answer questions of homeowners interested in applying similar radon reduction efforts to their houses.

Introduction

In March 1986, the New Jersey Department of Environmental Protection (DEP) reported to the United States Environmental Protection Agency (EPA) that significantly elevated radon concentrations had been measured in a single family dwelling in Clinton, New Jersey. Within 24 hours EPA's Air and Energy Engineering Research Laboratory (AEERL) personnel were in the house in Clinton where radon had been discovered. They were making measurements, diagnosing potential radon entry routes, and developing a radon reduction strategy for the house. Because the radon concentrations observed in this house far exceeded any residential radon measurements previously made in New Jersey, the New Jersey DEP conducted a general radon survey involving all interested Clinton homeowners. Charcoal canisters were distributed to the homeowners: the radon concentrations that were measured in 103 houses are summarized in Table 1. Due to the alarmingly high radon concentrations observed in many of the Clinton houses, the New Jersey DEP requested EPA's assistance in developing methods to reduce radon concentrations in the houses.

In April 1986, AEERL conducted screening visits in 56 homes in Clinton with the intent of selecting 10 homes where radon reduction techniques could be demonstrated. Evaluation criteria used in selecting the 10 houses included in the radon reduction project were: (1) the ability to identify and access the radon source in the house; (2) the ability to reduce radon concentrations with few potential complicating sources (e.g., fireplaces/chimneys); (3) elevated radon concentrations; (4) house sub-structures; (5) homeowner cooperation; (6) worker access to the house; (7) smokers in the house; (8) young children in the house; and (9) the time occupants spend in the house. Table 2 summarizes the

housing styles which characterized the Clinton radon screening area and identifies the different house types which were ultimately selected to be part of the radon reduction demonstration.

Table 1: Clinton Radon Levels

Concentraction pCi/l	No. of Houses	% of Sample
>2048	2	1.9
1024-2047	3	2.9
512-1023	13	12.6
256-511	17	16.5
128-255	17	16.5
64-127	12	11.7
32-63	12	11.7
16-31	14	13.6
8-15	5	4.9
4-7	6	5.8
<4	2	1.9
	103	

Table 2: Clinton Housing Styles

House Type	No.	No. Selected	No. Over 1000 pCi/l
Bi-Level	56	3	0
Split Level	27	4	3
Two Story (full basement)	9	1	1
Two Story (slab)	5	1	1
Miscellaneous (different builder)	30	1	0
	127*	10	5

*Of the 127 houses in the screening area only 103 participated in the New Jersey survey of radon levels and only 56 of these houses were included in the screening effort.

Radon Reduction Techniques

To provide maximun protection to the homeowners whose houses had been selected and to workers in the houses, all of the houses were opened to the

maximum extent possible, and fans were used in the houses to produce good ventilation. This was possible due to spring and summer outdoor temperatures which caused minimum discomfort to the homeowner. Each of the 10 houses received a detailed radon diagnostic evaluation before a house-specific radon reduction plan was developed. These evaluations included assessments of aggregate beneath the concrete slab floors, the presence of drain tiles surrounding the interior and exterior of the houses, cracks and penetrations in the floors and sub-grade walls, and the presence of large thermal bypasses that could exaggerate cold weather basement depressurization.

House-specific radon reduction techniques applied

The four split-level houses that were included in the study were each a combination of block wall basement and slab-on-grade sub-structures with a common wall. The slab-on-grade section of these houses had forced warm air heating ducts beneath the slab. These ducts were not tightly sealed at the joints and some of the ducts had clearly settled in the soil leaving a large gap between the register and the duct. A smoke pencil easily demonstrated the potential entry of soil gases from around the outside of the ducts and into the house via the heating registers.

The major solution to the radon problem for the slab-on-grade portion of the split-level houses was to seal the slab just below the registers with concrete and route new heating ducts into the attic. A plastic pipe with an in-line fan was then connected to the abandoned heating ducts, creating suction in the ducts and surrounding sub-slab area. In addition, two of the four split-level houses also had their floor/wall perimeter cracks sealed.

The basements of these houses were found to have several inches of crushed stone beneath the slab and both interior and exterior, below slab, drain tiles. Sub-slab suction was the radon reduction technique applied. This was achieved by inserting plastic pipe with in-line fans through openings created in the concrete slab in two houses and through existing sump holes which were later sealed in the other two houses. All of these sub-slab systems were vented to the outside through the roof. Major accessible cracks and penetrations in the floors and walls were also sealed (2).

The three bi-level houses, often referred to as split foyers or raised ranches, had completely finished living space on the lower level. The slab floor of the lower level was typically from 0 to 3 ft (0-100 cm) below grade. Two different approaches were tried for the three houses. In the first house, sub-slab suction was attempted with little success due to the lack of sufficient aggregate beneath the slab. As a second phase of radon reduction, the floor/wall perimeter crack was enlarged and a backer rod spacer placed in the crack before a tight polyurethane seal was used to cover the crack. This also left a channel beneath the backer rod around the perimeter of the house which was connected to a plastic pipe with an in-line fan. This technique permitted perimeter suction of the floor/wall crack which was exhausted through the roof.

The other two bi-level houses were subjected to a different radon reduction approach because of the difficult job encountered in the first bi-level when trying to enlarge the floor/wall crack. These two houses had their floor/

wall cracks sealed, but the primary radon reduction technique was applied from the exterior of the houses. Along one side of the two houses, a trench was dug to the level of the first hollow core foundation block. Three different penetrations were made in blocks along this wall. Two penetrations, made at the corners of the side wall, entered the void space in the foundation blocks on the front and rear walls. These penetrations permitted block-wall suction on the front, side, and rear walls. In the center of the side wall, a penetration was made through the block and into the loose backfill soil near the floor/wall crack beneath the house floor slab. By tying all three penetrations along the side wall into a common vertical plastic vent pipe equipped with an in-line fan, suction could be applied simultaneously to three walls and the sub-slab.

The two-story basement house had a much larger basement space than the split-level houses, requiring two sub-slab suction points at opposite ends of the basement. The two suction systems were not ducted together; each had its own fan. Basic sealing of cracks and floor and wall penetrations was performed.

The two-story slab-on-grade house was the house in Clinton where radon was first discovered. This house presented a special problem because it had sub-slab heating ducts similar to the slab portion of the split level houses. Unfortunately, since the house was two-story, new heating ducts had to be routed through the available space between floor joists in the ceiling of the first floor. This was both difficult and expensive since it required resurfacing some of the walls and ceiling. Again, the original heating ducts were used for sub-slab suction, similar to the split-level houses. In additon, due to the high radon levels in this house, a perimeter floor crack suction system (similar to the first bi-level house) was used.

A different type of split-level house built by another contractor was the tenth house to receive radon reduction treatment. This house was a combination slab-on-grade and crawl space with a common wall. The slab-on-grade portion of the house received an exterior wall suction technique similar to the last two bi-level houses; however, only one penetration point was used, to apply suction to one side wall and the rear wall.

The open soil in the crawl space of this house was covered by a fiber mat. On top of the mat, a network of perforated PVC pipe was completely covered by 10 mil polyethelene plastic. The plastic was held in place and sealed at the edges by wooden furring strips. The PVC pipe was connected to an in-line fan and vented to the outside.

Pre- and Post-Radon Reduction Measurements

Before and after the radon reduction plans were implemented, radon concentrations were determined by charcoal canisters and continuous radon monitors(1). The early charcoal canister data were obtained by the New Jersey DEP before the warmer springtime weather reduced the cold weather stack effect. Unfortunately, the pre-radon reduction continous monitor data were collected during warmer weather when radon concentrations were lower. Therefore, the pre- and post-

radon reduction data reported in Table 3 are only charcoal canister data. These are the only data available which compare cold weather concentrations before and after radon reduction.

Table 3: Clinton Radon Reduction Results

House No.	Concentration, pCi/l 4/86	12/86	Reduction, %	House Type
C1A	2254	4	99.8	
C4A	1523	4	99.7	= split level
C5A	635	5	99.2	(block basement/slab)
C8A	791	3	99.6	
C2B	691	6	99.1	= bi-level (slab partly
C6B	963	12	98.8	below grade)
C9B	418	16	96.2	
C3C	1190	6	99.5	= 2 story (slab)
C10D	1357	8	99.4	= 2 story (block basement +crawl)
C7E	426	7	98.3	= split level (crawl space /slab)

Discussion

The 10-house radon reduction demonstration in Clinton, New Jersey, was successful in showing homeowners with similar house types some effective ways of reducing radon concentrations. During the 10-house study in Clinton, five homeowners meetings were held to explain the techniques used to reduce radon concentrations and to elaborate on which approaches were working and which ones were not as effective or were not cost effective. To assist homeowners with different floor plans, 20 house-specific radon reduction plans were developed for other houses in the Clinton area. These plans along with the plans which were used in the 10-house project were made available at no cost to the Clinton residents.

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